

# Introduction to Botany. Lecture 11

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# Outline

- 1 Questions and answers
- 2 Anatomy of stem
  - Anatomy of mature stem
  - Structure of wood

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- 2 Anatomy of stem
  - Anatomy of mature stem
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# Previous final question: the answer

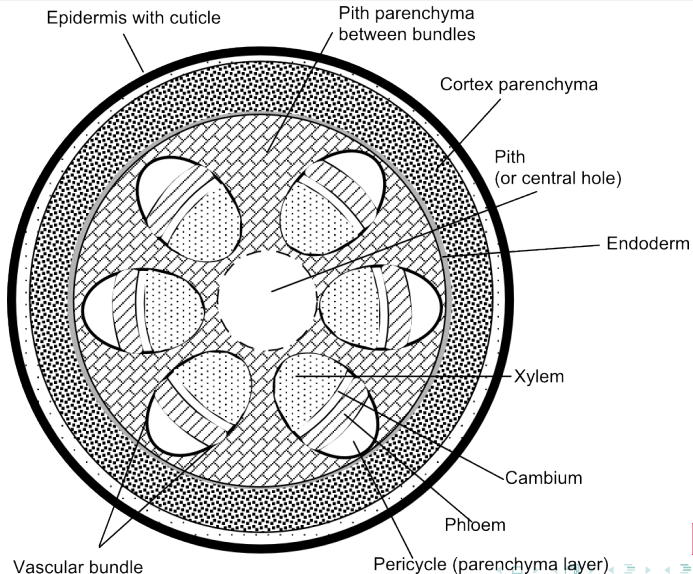
What is ataktostele?

## Previous final question: the answer

What is ataktostele?

- Dispersed (scattered) vascular bundles of monocots

# Primary structure of stem



# Cork cambium and origin of bark

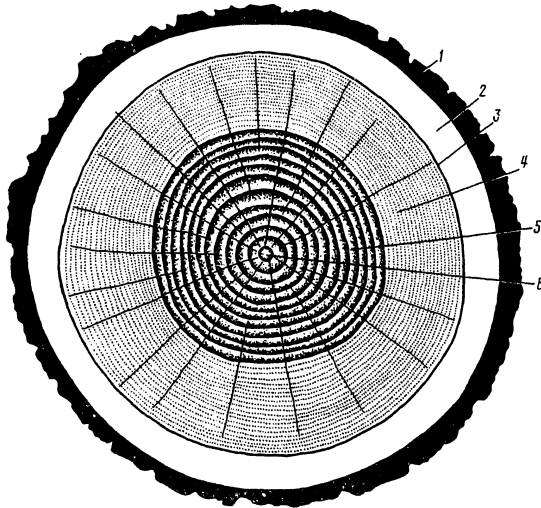
- **Bark** is everything outside vascular cambium, therefore, bark = secondary phloem + periderm
- Each year new layer of cork cambium appear from parenchyma cells of secondary phloem
- Consequently, bark consists of multiple and mostly uneven layers

# Bark, cork, periderm and wood

- **Bark** = secondary phloem + periderm
- **Periderm** = phellem + cork cambium + felloderm
- **Cork** = phellem
- **Wood** = trunk — bark, or simply secondary xylem

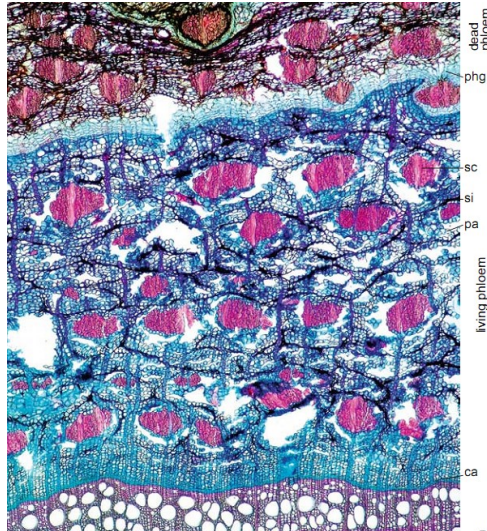


# Bark and wood



Bark = 1 + 2, wood is 5 (heartwood) and 6 (sapwood)

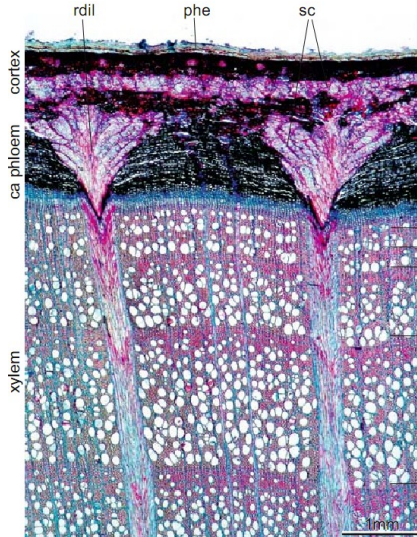
# Renewal of bark in sea buckthorn (*Hippophaë rhamnoides*)



# Secondary phloem

- Forms outside vascular cambium
- Rich of fibers
- Does not form annual rings
- Has rays of parenchyma cells, sometimes wedge-shaped (**dilated**)

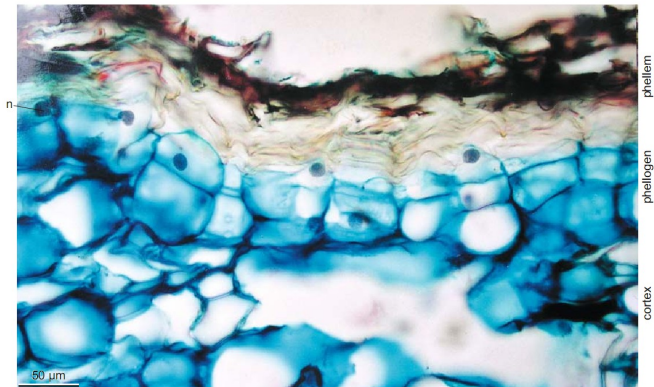
# Dilated rays of beech (*Fagus* sp.)



# Periderm

- Periderm is the product of cork cambium
- 99% of periderm is a **phellem** (cork), thick outside layer
- **Phelloderm** is a tiny layer of living cells inside of cork cambium

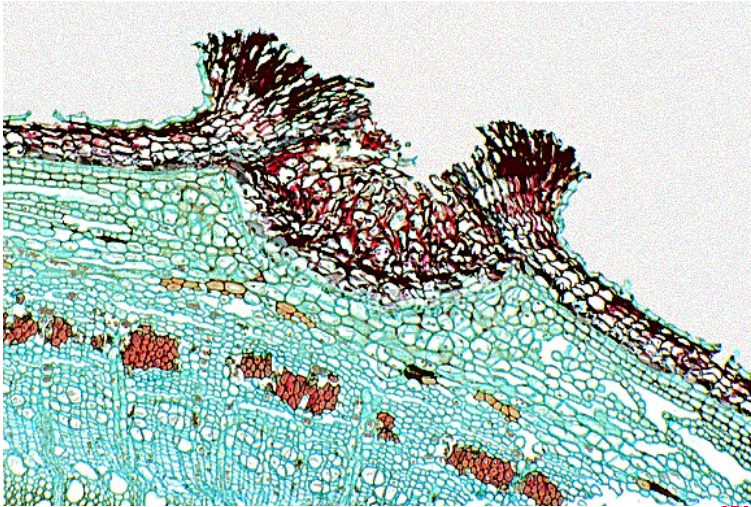
# Formation of bark zone in medlar (*Mespilus germanica*)



# Lenticels

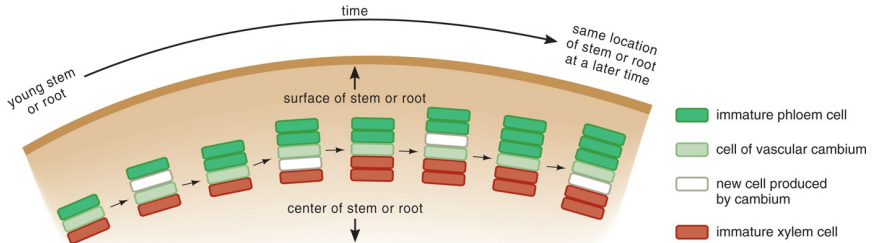
- **Lenticels** are specialized regions of periderm; they supply stem cells with oxygen
- In order to produce lenticel, some cells of cork cambium divide and grow much faster than others

# Lenticel of elderberry (*Sambucus* sp.)

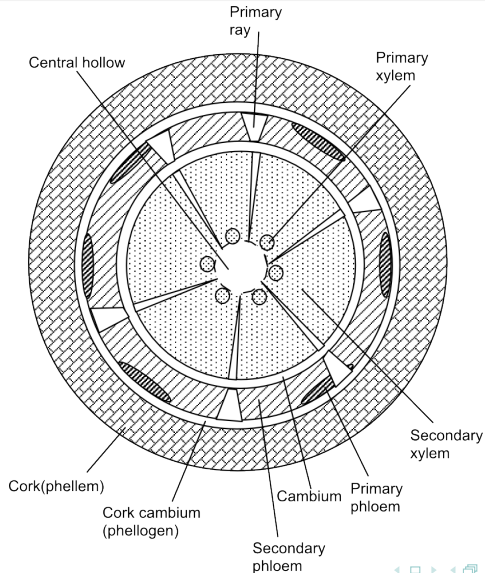




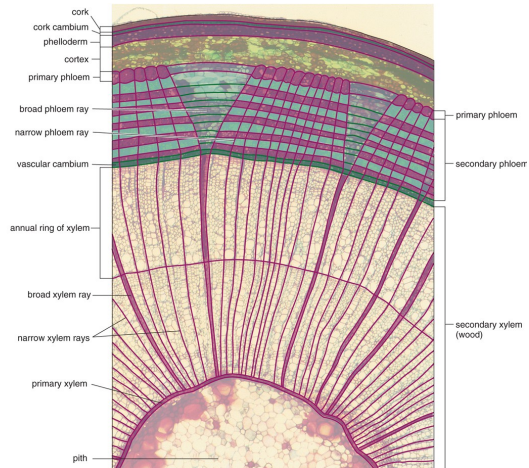
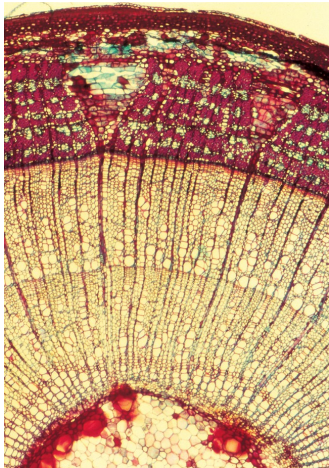
# How cambium is working



# Secondary structure of stem (scheme)



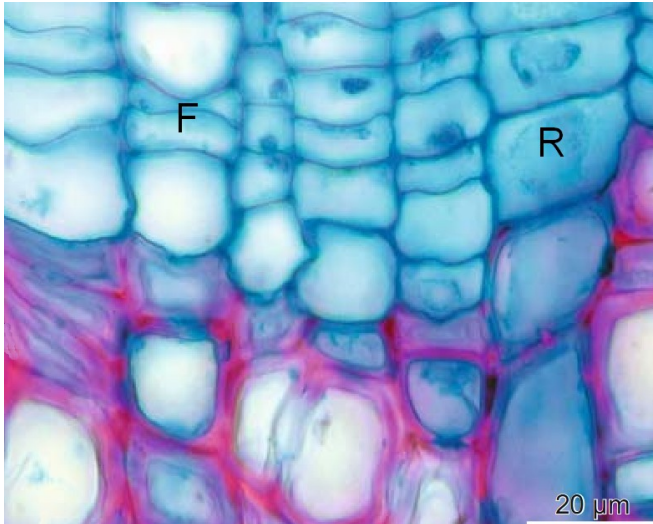
# Secondary structure of stem (photo and explanations)



# Secondary xylem and rays

- Secondary xylem, or wood, is the product of vascular cambium
- Some cambium cells are **fusiform initials**; they form axial vessel elements
- Other cambium cells are **ray initials**; they form rays (parenchyma + tracheids)
- **Rays** provide horizontal transport of water; **axial system** provide vertical transport

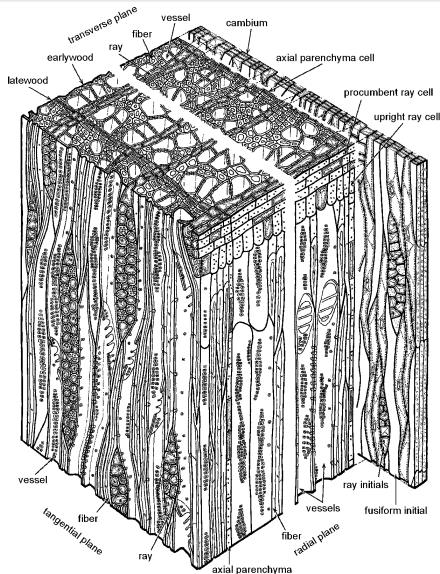
# Fusiform and ray initials



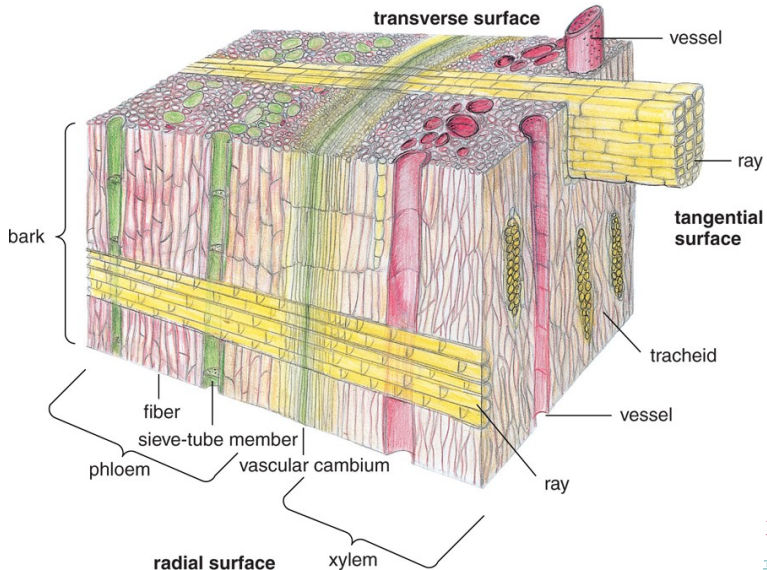
# Three planes of view

- **Transverse\*** (cross-section)
- **Radial** (longitudinal section from center to periphery and perpendicular to stem surface)
- **Tangential** (longitudinal section parallel to stem surface)

# Three plains of maple (*Acer* sp.) wood



# Three planes again (the scheme)





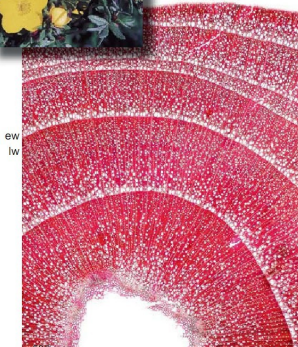
# Earlywood and latewood

- **Earlywood** (springwood) contains more parenchyma and often have larger vessel elements
- **Latewood** (summerwood) often have small vessel elements and looks darker

# Diffuse and ring porous wood

- In **ring porous** wood (like in red oak) bigger vessel elements concentrate in earlywood
- In **diffuse porous** wood larger vessel elements spread across early- and latewood (American elm)

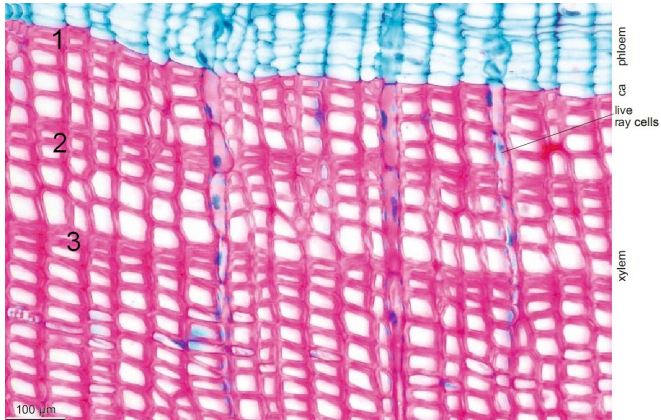
# Diffuse and ring porous wood in two species of cinquefoil (*Potentilla* spp.)



# Annual rings

- Interleaving early- and latewood from to sequential years form an impression of annual ring
- “Ring” is just a layer of darker (i.e., smaller) cells
- Tropical trees do not form annual rings

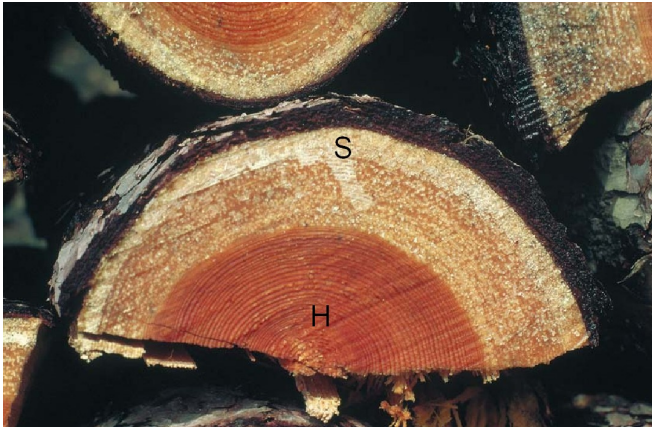
# Annual rings in juniper (*Juniperus* sp.)



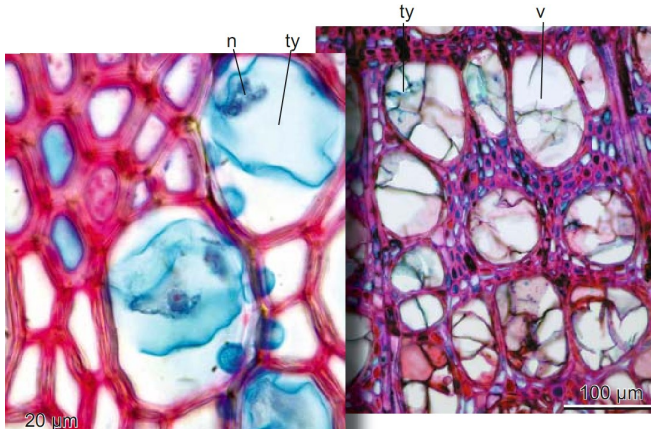
# Sapwood and heartwood

- **Sapwood** is a peripheral layer of working xylem, it usually has relatively light color
- **Heartwood** is a central, non-functional, old, dark-colored xylem

# Sapwood and heartwood of European pine (*Pinus sylvestris*)



# Tyloses



Tyloses control the winter functioning of vessels



# Two taxonomic terms

“Gymnosperms” All seed plants except angiosperms =  
Spermatophyta – Magnoliopsida

“Dicots” All angiosperms except monocots =  
Magnoliopsida – Liliidae

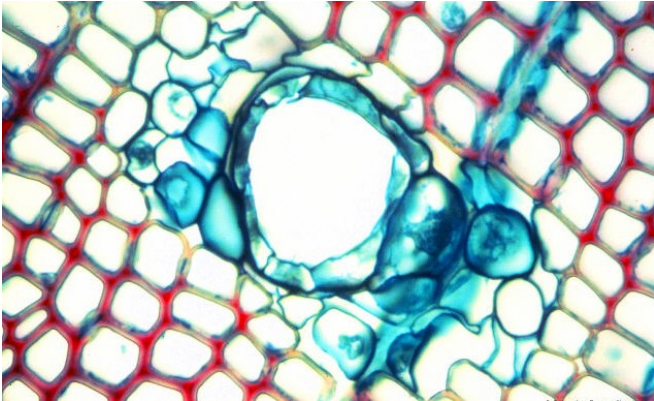
# Conifer wood

- Simpler structure, few cell types
- Simple rays
- Sometimes have **resin ducts**; resin secreted by epithelial cells

# Ginkgo (*Ginkgo biloba*) wood (not a conifer, but gymnosperm)



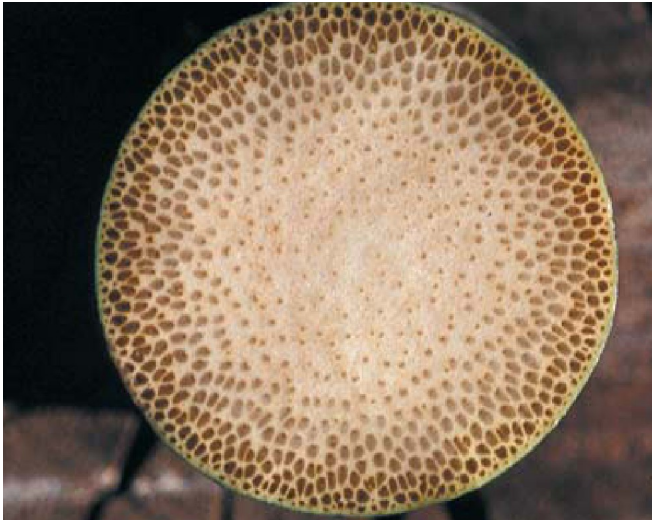
# Resin duct in pine wood (©BSA)



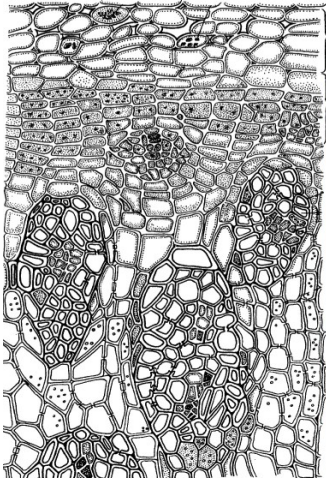
# Monocot “wood”

- Most of monocots do not have lateral meristems and therefore have no true wood
- Palms have only primary tissues; their trunk widens from bottom to top
- Some monocots (dragon trees) have **anomalous secondary growth**

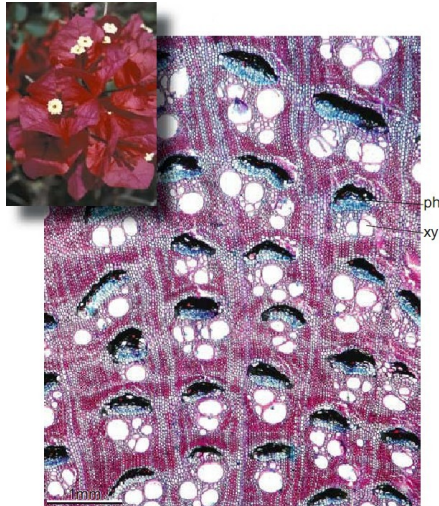
# Cross section of palm (*Phoenix canariensis*) trunk



# Dragon tree (*Dracaena draco*)



# Anomalous secondary growth in *Bougainvillea* (*Bougainvillea spectabilis*)





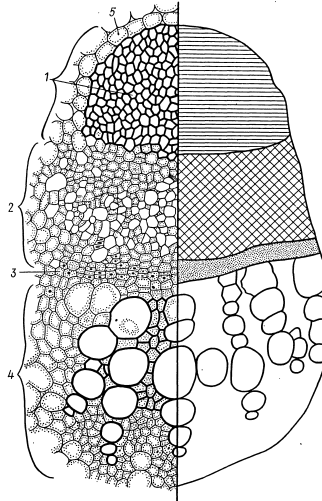
# Summary

- **Bark** consists of secondary phloem and cork
- **Wood** is a secondary xylem

## Final question (1 point)

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Where is a cambium?



# For Further Reading



J. E. Bidlack, Sh. H. Jansky.  
*Stern's introductory plant biology*. 12th edition.  
McGraw-Hill, 2011.  
*Chapter 6.*



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.  
*Plant Biology*. 2nd edition.  
Thomson Brooks/Cole, 2006.  
*Chapter 5.*